Extraction of the F_2 and F_L structure functions from inclusive e+p and e+A at the EIC

R. Debbe BNL

The neutral current inclusive e-nucleon cross section can be written as a combination of two terms:

$$\sigma_r(x, Q^2, y) = \frac{d^2\sigma}{dxdQ^2} \cdot \frac{Q^4 x}{2\pi\alpha^2 Y_+} = F_2(x, Q^2) - \frac{y^2}{Y_+} \cdot F_L(x, Q^2) \,,$$

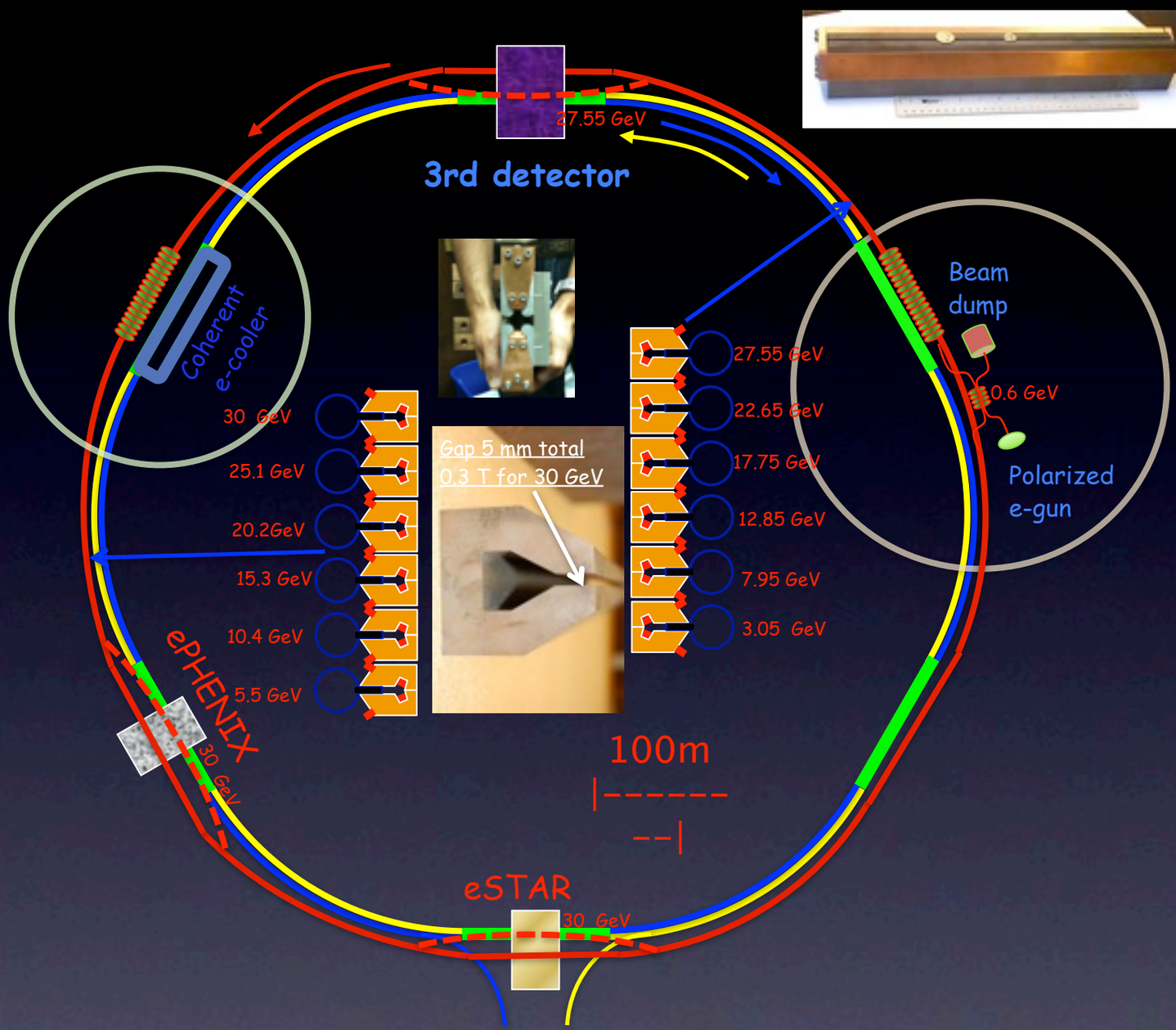
"reduced cross section"

$$\frac{d^2\sigma^{NC}_{e^{\mp}p}}{dxdQ^2} = \frac{2\pi\alpha^2_{em} Y_+}{xQ^4}\left(F_2 - \frac{y^2}{Y_+}F_L \pm \frac{Y_-}{Y_+}xF_3\right)$$

why drop F3?

$F_2\alpha(\sigma_T + \sigma_L)$ $F_L \sim\sigma_L$ where σ_T and σ_L are the γ^*P cross sections for transverse and longitudinally polarized virtual photons. The value of F_2 is determined by the sum of quark and anti-quark distributions, whereas F_L depends on quark + gluon distributions. Above some value of Q^2, quark PDFs are much smaller than gluon PDFs hence F_L is mainly "driven" by gluon PDFs

Explain how Fl is extracted as the slope of fits in Q2 and x bins. Needs to collect data at different values of the electron beam, and for each electron beam value, needs at least three hadron beam values.



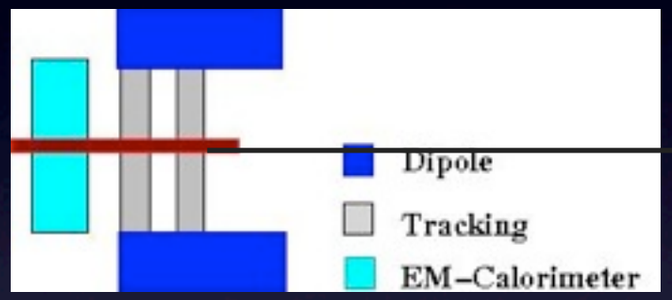
Bring some details on planed eRHIC

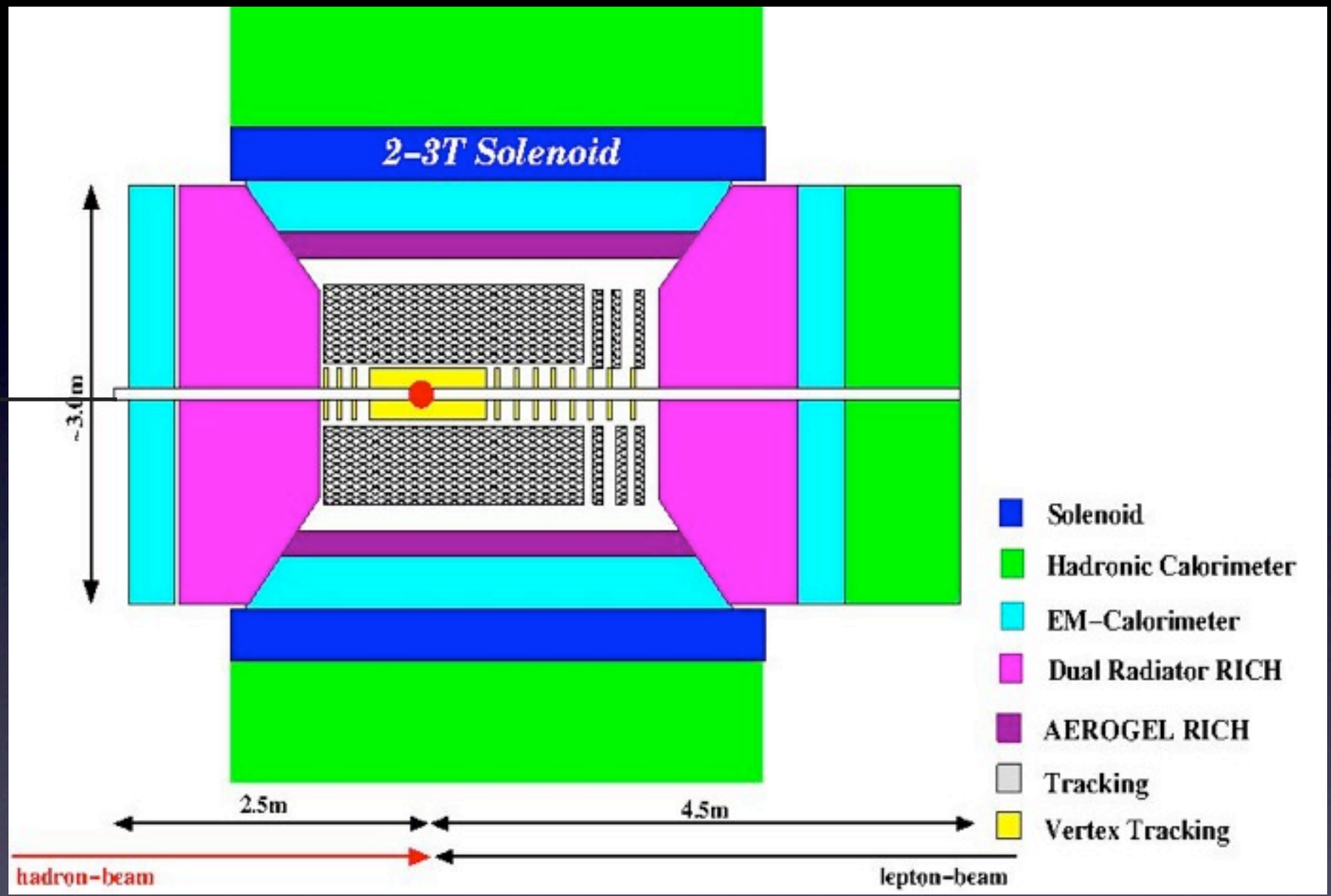
Planned beam energies and luminosities

sqrt(s)	31.6	38.7	44.7	51.	70.7	44.7	54.8	63.2	72.1	100.
Beam Energies	5x50	5x75	5x100	5x130	5x250	10x50	10x75	10x100	10x130	10x250
ep	0.39e+33	1.3e+33	3.1e+33	5.0e+33	9.7e+33	0.39e+33	1.3e+33	3.1e+33	5.e+33	9.7e+33
eA	2.5e+33	8.3e+33	11.4e+33	18.0e+33		2.5e+33	8.3e+33	11.4e+33	18.0e+33	

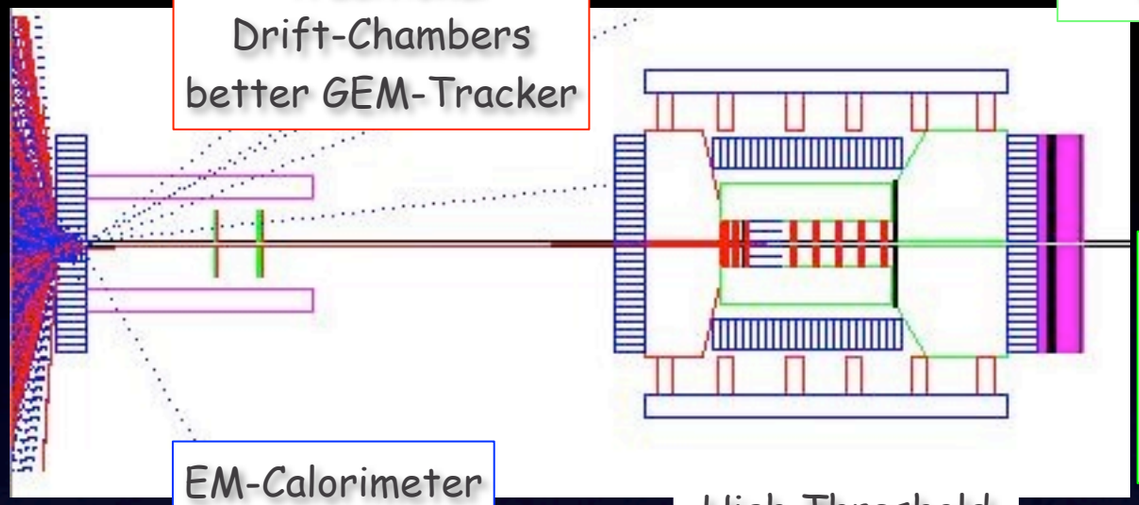
sqrt(s)	63.2	77.5	89.4	101.9	141.4	77.5	94.9	109.5	124.9	173.1
Beam Energies	20x50	20x75	20x100	20x130	20x250	30x50	30x75	30x100	30x130	30x250
ep	0.077e+33	0.26e+33	0.62e+33	1.4e+33	9.7e+33	0.015e+33	0.05e+33	0.12e+33	0.28e+33	1.9e+33
eA	0.49e+33	1.7e+33	3.9e+33	8.6e+33		0.1e+33	0.34e+33	0.77e+33	1.7e+33	

The eRHIC detector





high acceptance $-5 < \eta < 5$ central detector
good PID (π,K,p and lepton) and vertex resolution (< 5μm)
tracking and calorimeter coverage the same → good momentum resolution, lepton PID
low material density → minimal multiple scattering and brems-strahlung
very forward electron and proton/neutron detection → maybe dipole spectrometers


Si-Vertex
as Zeus
Central Tracker
as BaBar
Traditional
Drift-Chambers
better GEM-Tracker
Hadronic
Calorimeter
Dual-Radiator
RICH
as LHCb /
HERMES
EM-Calorimeter
PbGl
High Threshold
Cerenkov
fast trigger on e'
e/h separation

$$Q_s^2(x,A) \sim cQ_0^2\left(\frac{A}{X}\right)^{1/3}$$

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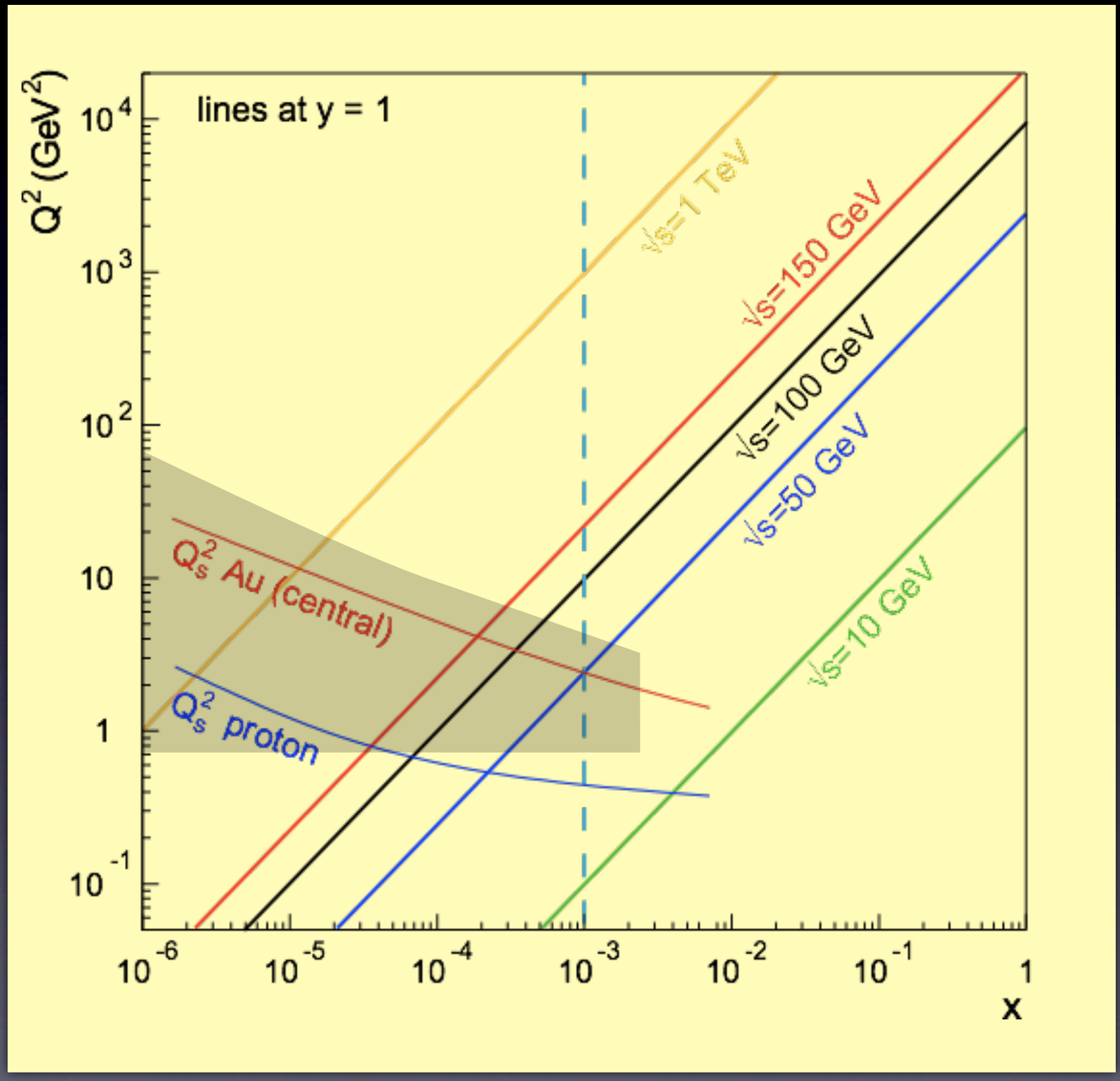
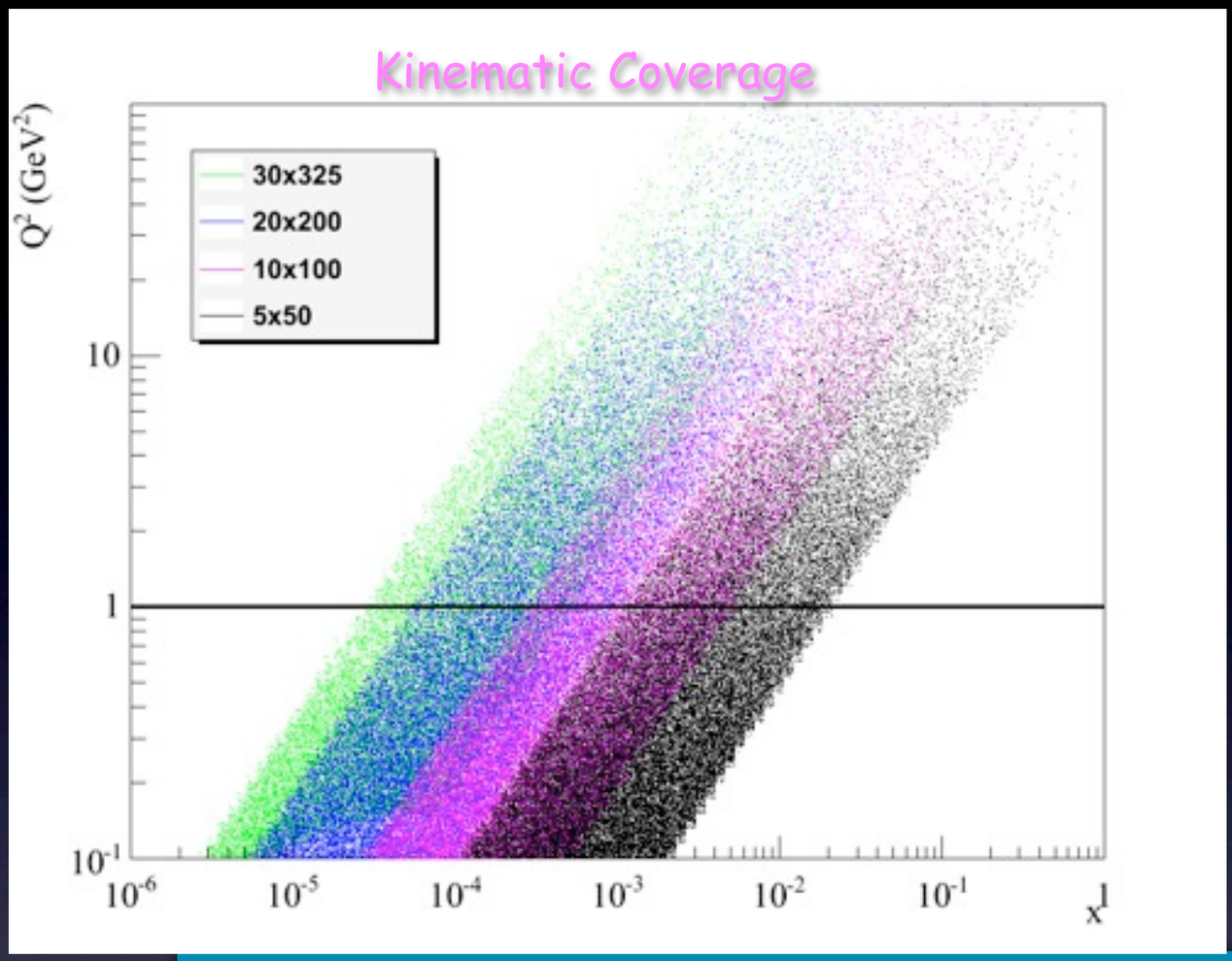
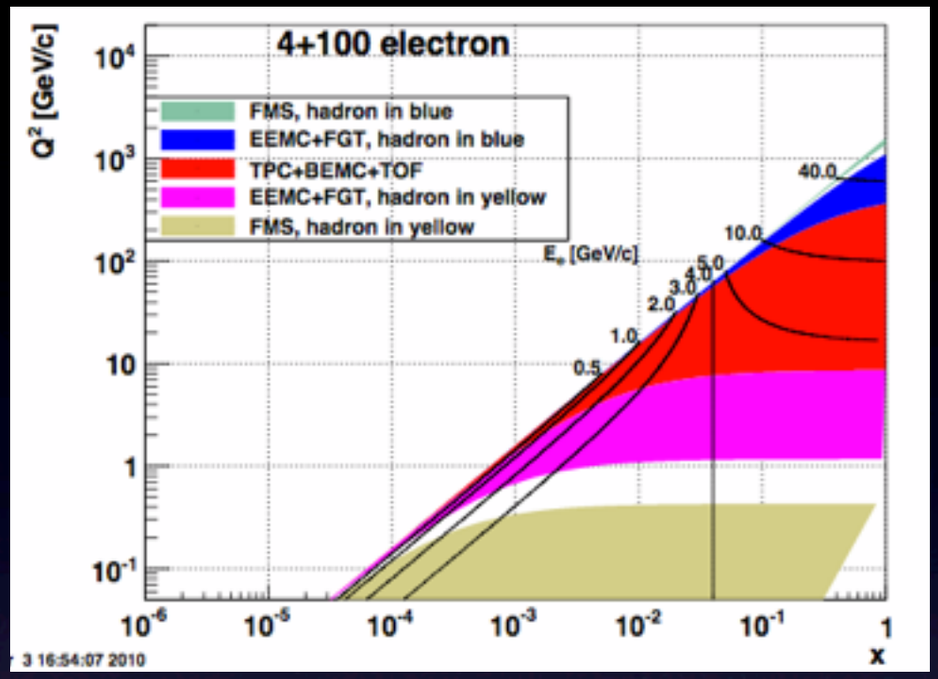


$$\frac{d^2\sigma^{NC}_{e^{\mp}p}}{dxdQ^2} = \frac{2\pi\alpha^2_{em}Y_+}{xQ^4}(F_2 - \frac{y^2}{Y_+}F_L \pm \frac{Y_-}{Y_+}xF_3)$$

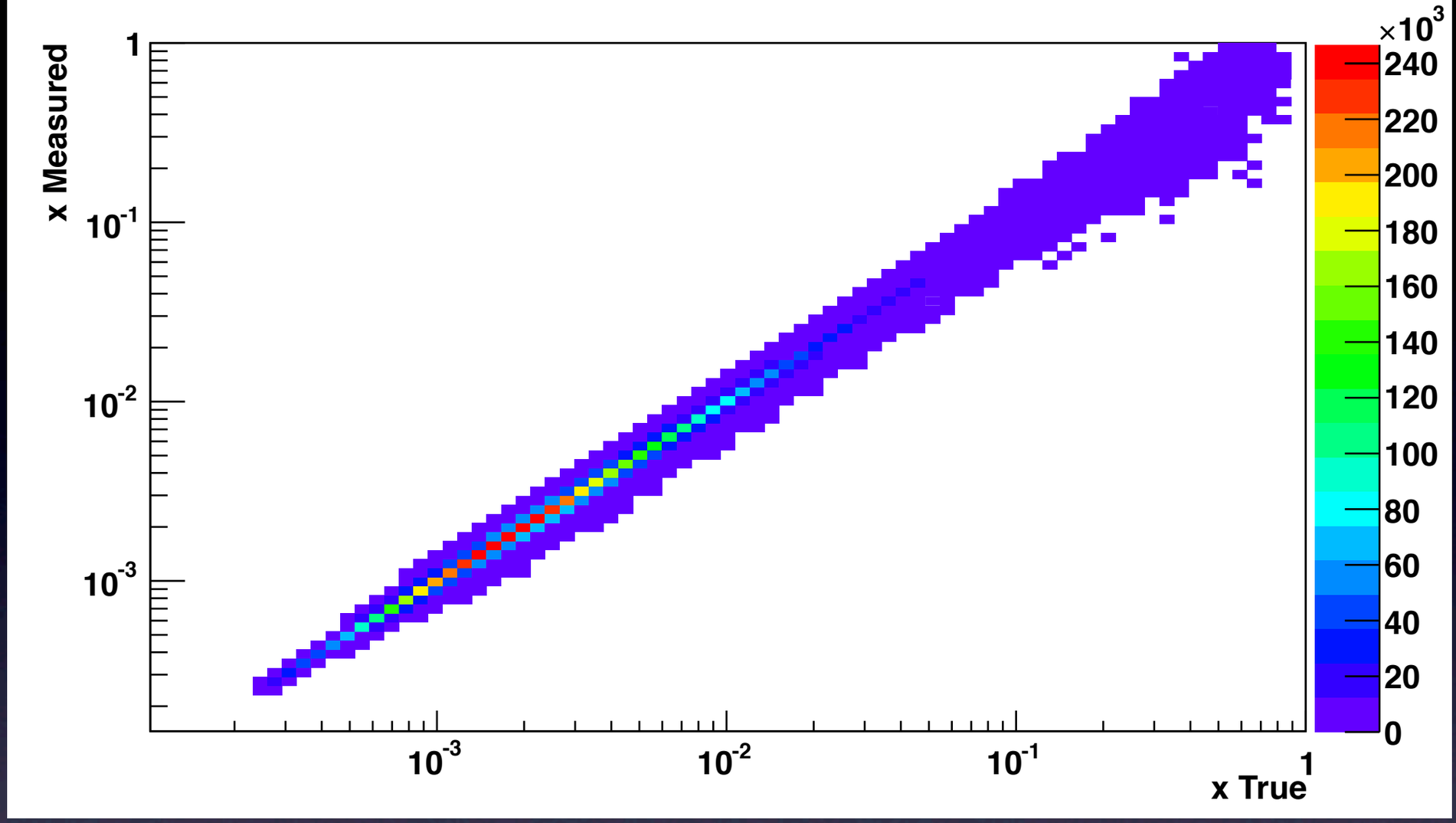
Kinematic Coverage



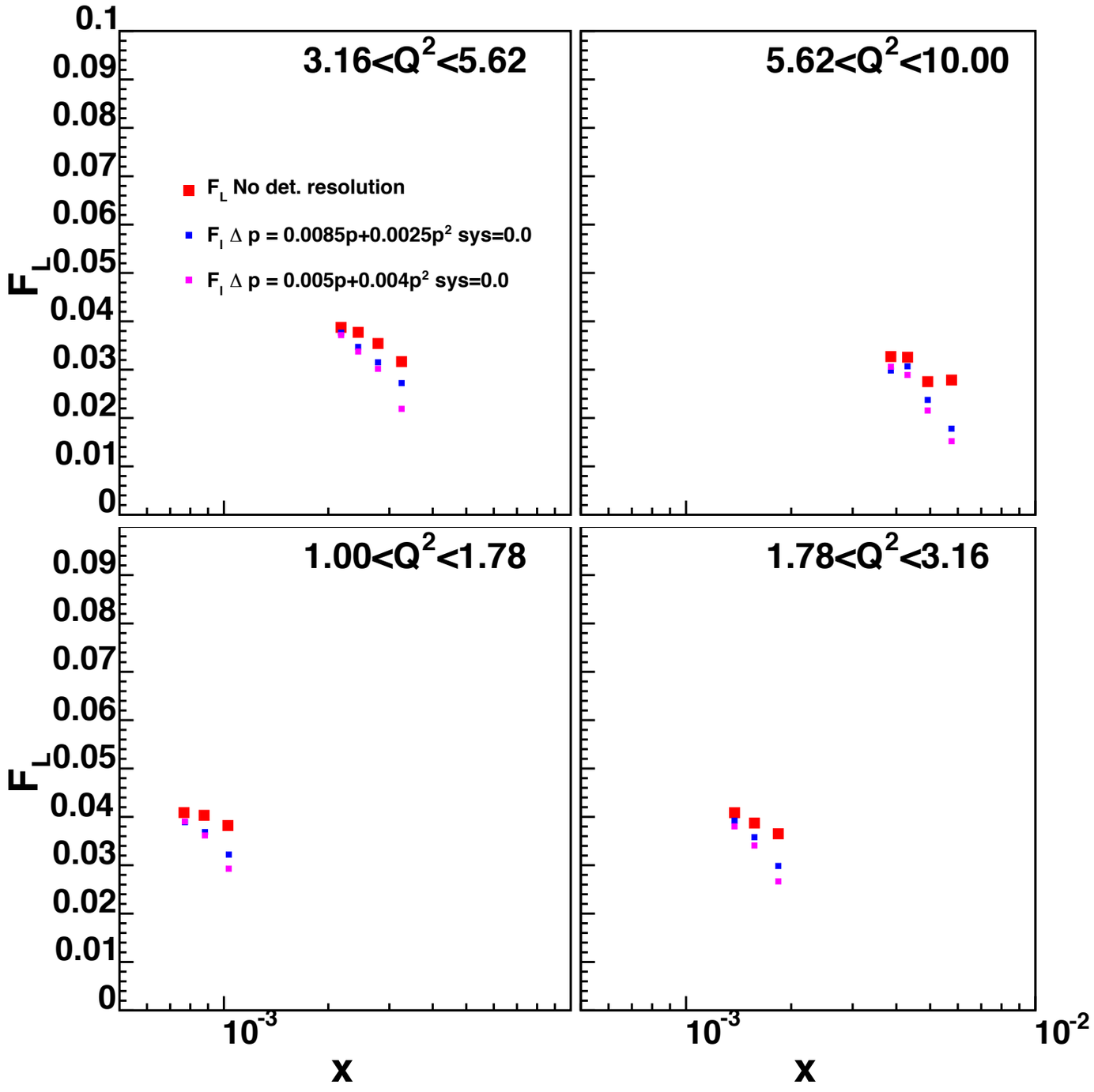
$$\frac{d^2\sigma^{NC}_{e^{\mp}p}}{dxdQ^2} = \frac{2\pi\alpha^2_{em}Y_+}{xQ^4}\left(F_2 - \frac{y^2}{Y_+}F_L \pm \frac{Y_-}{Y_+}xF_3\right)$$

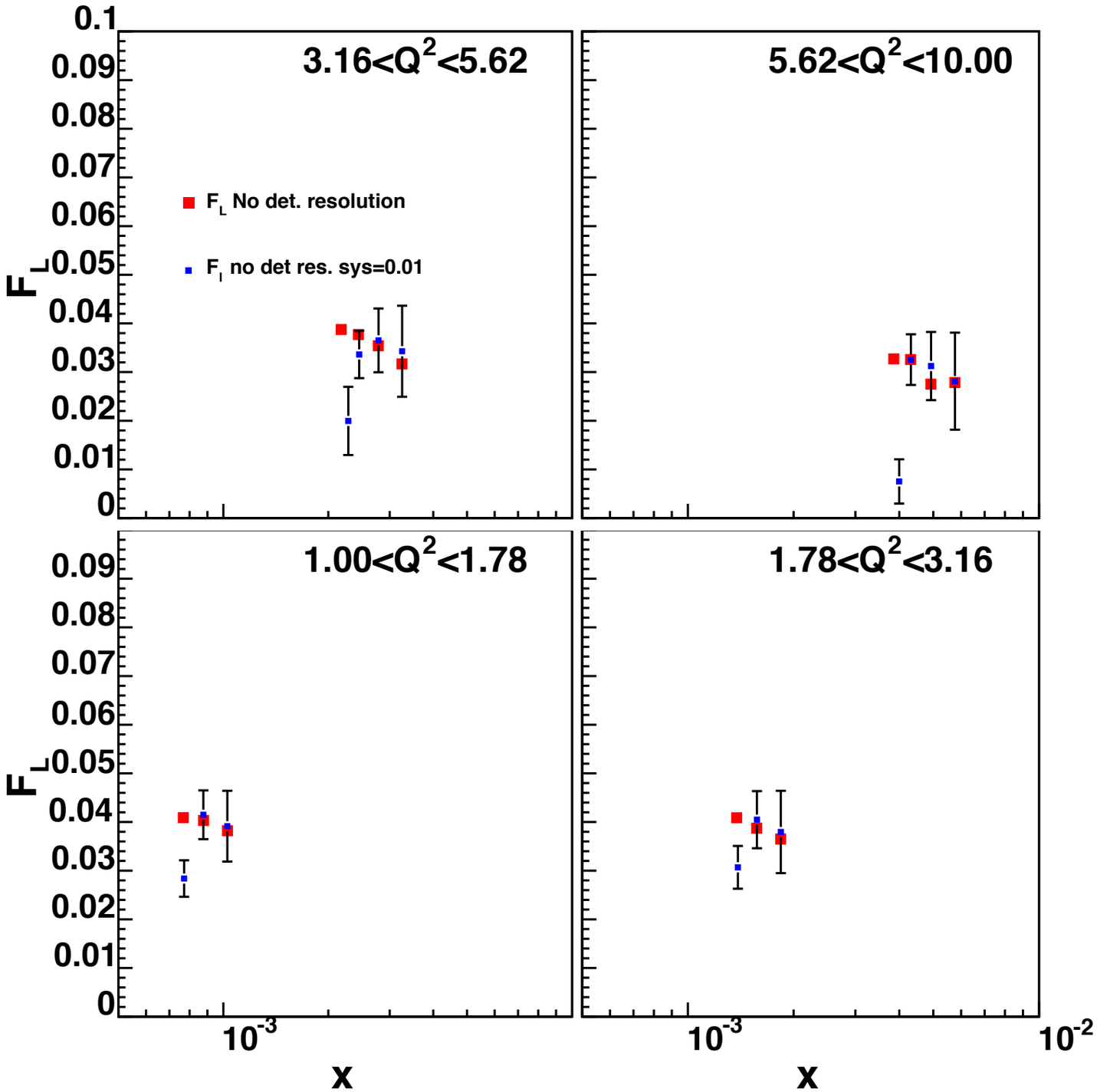


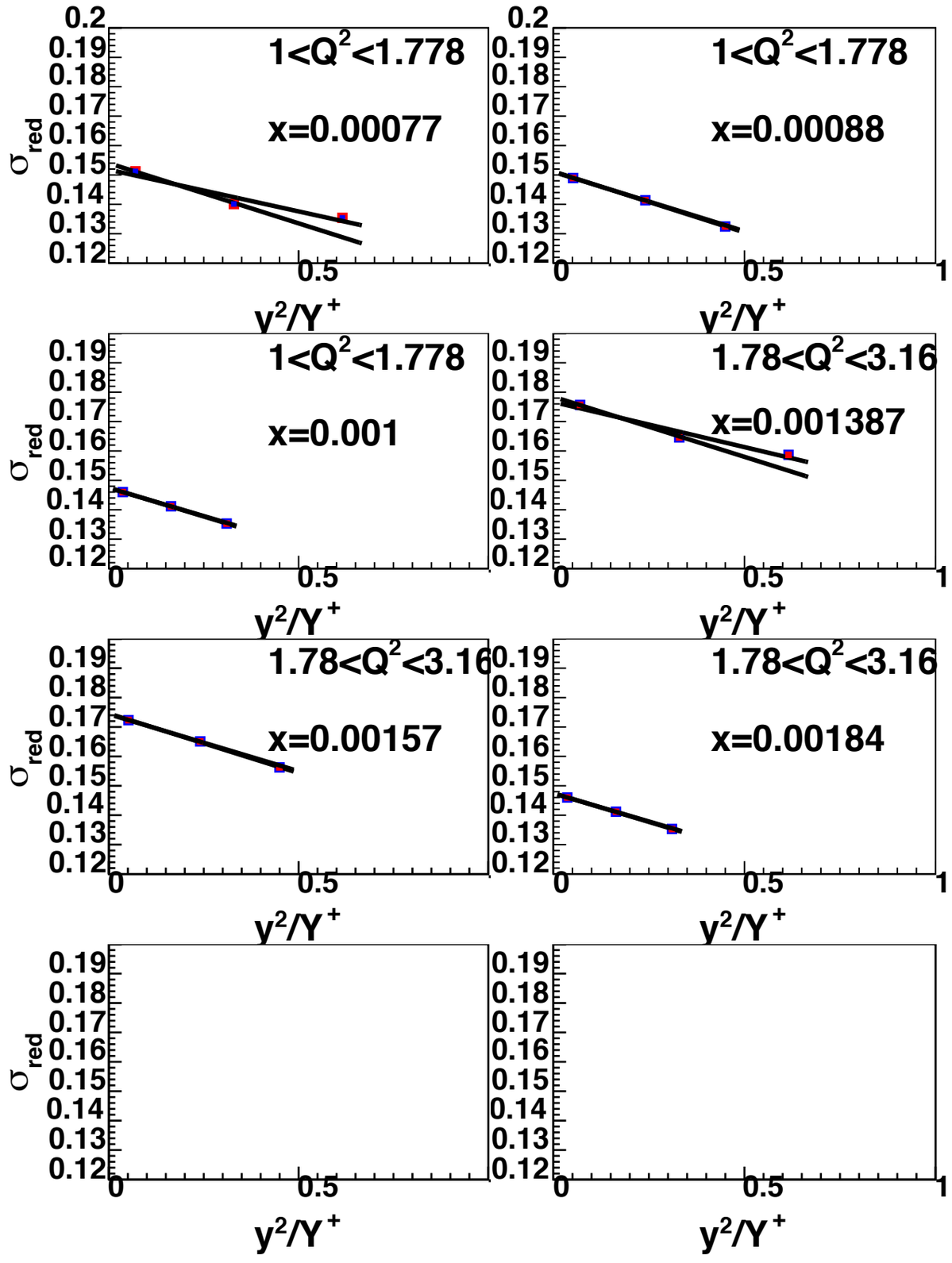
Need to generate similar figure without STAR but with eRHIC detector components


x Measured
1
10^{-1}
10^{-2}
10^{-3}
10^{-3}
10^{-2}
10^{-1}
1
x True
$\times 10^3$
240
220
200
180
160
140
120
100
80
60
40
20
0

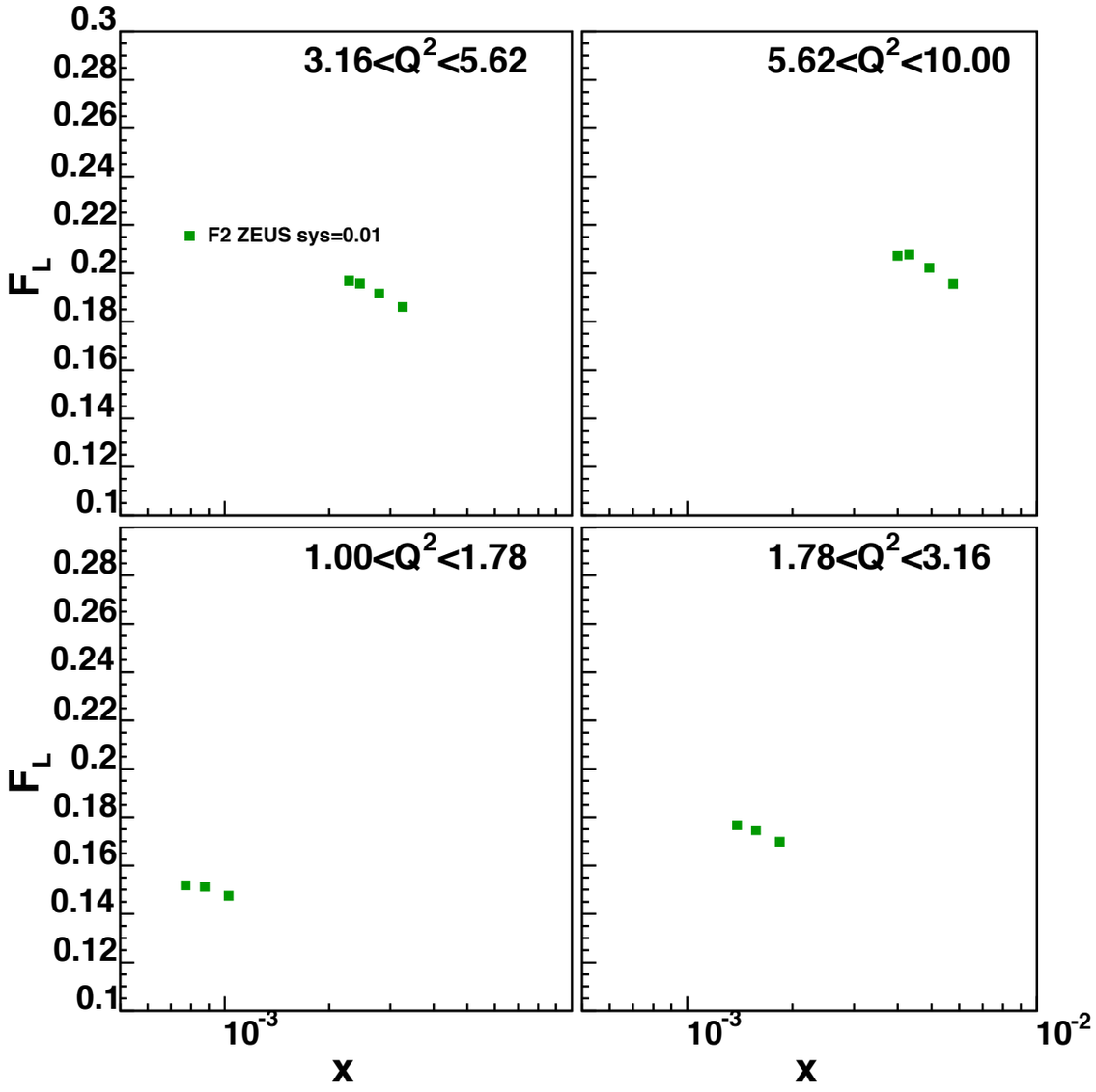
Details of F2 and Fl extraction in e+p with PEPSI from data binned in Q2 and y


3.16<Q²<5.62
5.62<Q²<10.00
1.00<Q²<1.78
1.78<Q²<3.16
F_L No det. resolution
F_l Δ p = 0.0085p+0.0025p² sys=0.0
F_l Δ p = 0.005p+0.004p² sys=0.0
F_L
x
10^-3
10^-2
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0


3.16<Q²<5.62
5.62<Q²<10.00
1.00<Q²<1.78
1.78<Q²<3.16
F_L No det. resolution
F_L no det res. sys=0.01
F_L
x
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
10^-3
10^-2



This figure will change it will have six panels.
Needs explanation for the lowest x value points not lining up.



Same figure for F2